BONNEVILLE INTERNATIONAL RACEWAY SALT LAYDOWN PROJECT FEASIBILITY

prepared for

SAVE THE SALT

and

REILLY INDUSTRIES

prepared by

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BONNEVILLE INTERNATIONAL RACEWAY
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EXECUTIVE SUMMARY

This report summarizes the results of a study which addressed the feasibility of moving sodium chloride salt from a retired primary pond in the Reilly Wendover facilities to the international raceway area of the Bonneville Salt Flats. The results of field surveys, investigations, and engineering analyses indicate that it is feasible to transport and lay down salt on the raceway area.

The single primary pond investigated for this study has an area of approximately 880 acres and could provide enough salt to add an additional 2" of salt thickness to the racetrack and salt flat area of 28 square miles.

The configuration, pumping rate, duration of pumping, and operation methods significantly impact the amount of salt crystallizing on the salt flats each year. Several alternative plans have been studied. Alternatives addressed variations in the following features:

- Area of salt flats (brine containment area).
- Rate of pumping of brackish water wells (the transport medium).
- Size of primary (salt) pond where dissolving of salt would occur.
- Duration of pumping.
- Specific gravity of brine (salt concentration) leaving salt pond.
- Permeability of soils and groundwater levels beneath canals, ponds, and salt flats.
- Brine Distribution System

Results of combinations of the above variables are summarized in this report. The proposed plan includes the following parameters:

- Salt flat brine containment area = 28 square miles
- Rate of brackish water pumping = 6,000 gpm
- Initial portion of salt pond = 390 acres
- Duration of pumping = 6 months
- Specific gravity of brine leaving salt pond = 1.18
- Vertical permeability of salt flat soils = 1 x 10^{-6} cm/sec

The 28-square-mile area referenced above would be bounded on the west and northwest by the edge of the existing salt crust; on the south by Interstate I-80 and the Salduro Loop; on the southeast by a low salt windrow; on the east by earth dikes beside brine collection ditches and by proposed containment dikes; and, on the north by topographically higher ground.

The proposed alternative modeled during this study would transport up to 1,500,000 tons per year of salt, resulting in an additional salt thickness up to 0.42 inch per year. At that rate, the salt deposited in the primary pond considered in this study would be exhausted in 4 to 5 years. Other sources of salt (in retired primary ponds) exist at Reilly.

The proposed plan would include 4 new brackish water wells in the alluvial fan aquifer, cleaning and some enlargement of existing brackish water supply ditches, cleaning of two timber culverts under I-80, two railroad crossings, use of an existing transfer canal, some modifications in the primary pond, construction of approximately 3.8 miles of new canal, closing of breaches in the Salduro Loop, containment dikes along the northeast portion of the raceway and the overrun, salt dikes or windrows on the southeast of the raceway, lift (pumping) stations, a distribution system providing sheet flow onto the salt flats, and frontage road improvements.

The modelling of the system included solution, crystallization, and evaporation properties of sodium chloride, magnesium chloride, and potassium chloride. It also included anticipated seepage and evaporation losses in the conveyance and solution system. The limiting factors in transporting salt to the salt flats are the weather and the quantity of water. The greater the quantity of water, the more effective and efficient the system becomes. Evaporation losses in the conveyance system become excessive during late spring and summer months. Therefore, it is not recommended that pumping be continued beyond the month of April. The total thickness of salt deposition for a pumping period of October through March is essentially equal to that for the pumping period of November through April. If pumping were delayed to allow racing beyond mid-November, it would result in some reduction of salt deposition on the track.

Total project costs have been conservatively estimated at $797,000. The prices used in the cost estimate are for new construction and equipment at market prices, and for contractors mobilizing from Salt Lake City. The cost estimate also includes costs for work and several features which may be found unnecessary during final design. In addition, the use of Reilly wells would reduce well construction costs. The use of Reilly equipment may result in additional significant savings. It is anticipated that potential cost savings could be as much as $210,000, resulting in a construction cost of $587,000. This does not include other additional savings in well construction which the racing associations have indicated were possible through their contacts.

The proposed project schedule would result in immediate field investigation and final design effort with the entire system constructed and operating within 14 months of "notice-to-proceed".

It is recommended that for an immediate beneficial effect, the containment dike from the south end of Floating island to the north end of the Reilly collection ditches be constructed prior to the winter of 1991-92. The above work can be accomplished during the final design for the remainder of the project.

INTRODUCTION

There has been considerable concern about the thickness of the crystalline salt crust at the Bonneville Salt Flats International Raceway. Racing groups, public agencies, industry, and other groups have questions about the thickness, changes in the thickness, and holes in the crust near the speedway. This report does not address those issues. It does, however, present results from a feasibility study which investigated the transport of sodium chloride salt from a retired primary pond south of I-80 owned by Reilly Industries and laydown or crystallization of that salt onto the speedway and surrounding salt flats. The location of the speedway and general area is east of Wendover, Utah, and is shown on Figure 1. More details of the layout of roads, the speedway, and industry facilities are shown on the map of Plate 1 in the pocket of this report.

Bingham Engineering was retained by "Save the Salt" and Reilly Industries to conduct the feasibility study. It is our understanding that "Save the Salt" represents several racing groups with respect to the concerns of the condition of the salt crust. This work was coordinated with Messrs. Rick Vesco, Larry Volk, Mark Dees, and Elmo Gillette of the racing associations and Messrs. Clarence Prentice, John Fendt, and Glen Wadsworth of Reilly Industries.

Study efforts included field surveys, field inspections of the project area and specific sites, review of numerous previous studies and technical information, engineering analyses, review of numerous alternatives with the sponsors, and cost estimating.

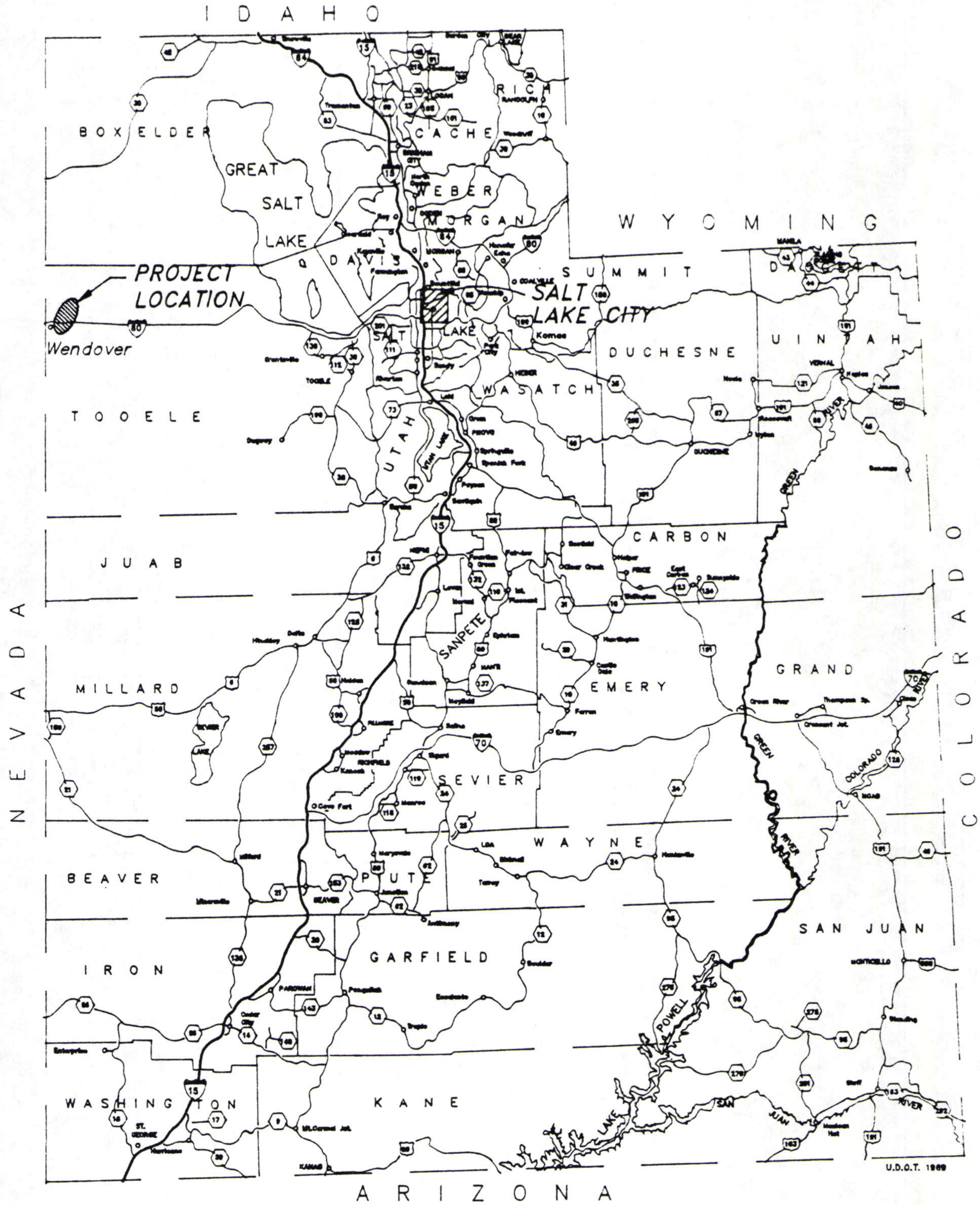
SUPPLY & CONVEYANCE FEATURES

General

Following are brief discussions of the features of the proposed and alternate plans. The order is generally as the process would occur - from the wells to the primary pond and then to the salt flats. Systems with a pumped water supply of 3000 to 6000 gpm have been evaluated. Stationing (increments of 100 feet) is shown on Plate 1 and corresponds to references below and generally to the cross-sections of Appendix A. Some of the objectives in designing the conveyance system and other related features is to minimize seepage losses in all areas and to minimize evaporation in the brackish water channel and before the brine leaves the pond area.

Wells and Aquifer Data

Three aquifers exist in the Salt Flat region, they are alluvial-fan aquifer, shallow brine aquifer and valley-fill aquifer (Stephens, 1974). The aquifer of interest for this study is the alluvial-fan aquifer. This aquifer yields brackish water.



LOCATION MAP
FIGURE 1

In 1946 through 1949, 22 wells were drilled into the alluvial-fan aquifer for Bonneville, Ltd. It is our understanding that 27 wells were proposed but only 22 were drilled (personal communication with Glen Wadsworth 6/12/91). The wells were drilled to depths of 104 feet to 364 feet. It is our understanding that 5 of the wells are in use today for the production of potash at Reilly Industries. The locations of the currently producing wells are shown on Plate 1. All of the producing wells are located west of the county road.

Currently, none of the wells are flowing as they reportedly did at the time of drilling. Figure 2 presents water level information for well FW-7 and Wendover precipitation data. Stephens (1974) and Lines (1979) recognized a correlation in the precipitation and water levels in the wells. This trend, a three year lag, is evident in the data but is not as well reflected in more recent data. Water level data were obtained from the driller's log, from Turk (1969), from USGS publications, and from a field measurement made during this study.

As mentioned earlier, the wells produce brackish water. Chemical analyses have been performed on several samples. Results are presented in Table 1. The analyses were made by Bonneville Ltd. and presented in Turk (1969). Data from Table 1 was used in the transport model. Additional chemical analyses of the brackish water are included in Appendix B.

Table 1

ALLUVIAL FAN AQUIFER BRACKISH WATER CHEMISTRY

Bonneville International Raceway Salt Laydown Project

Well No.	Date	Specific Gravity (20°C)	Percentage by Weight					
			KCl	$MgCl_2$	NaCl	SO_4	Temp. (°C)	Temp. (°F)
FW3	8-4-67	1.0040	0.05	0.11	0.64	0.02	35	95
FW5	8-4-67	1.0039	0.05	0.08	0.57	0.02	31	88
FW9-A	8-4-67	1.0037	0.05	0.11	0.50	0.02	25.5	78
FW11	8-5-67	1.0037	0.05	0.11	0.50	0.02	25.5	78
Average		1.004	0.05	0.10	0.55	0.02		

In 1966 Well No. 9A was pumped for eight hours. The pumping rate was 1650± gpm. Drawdown was observed in well No. 9 and well No. 10. The well was again pumped

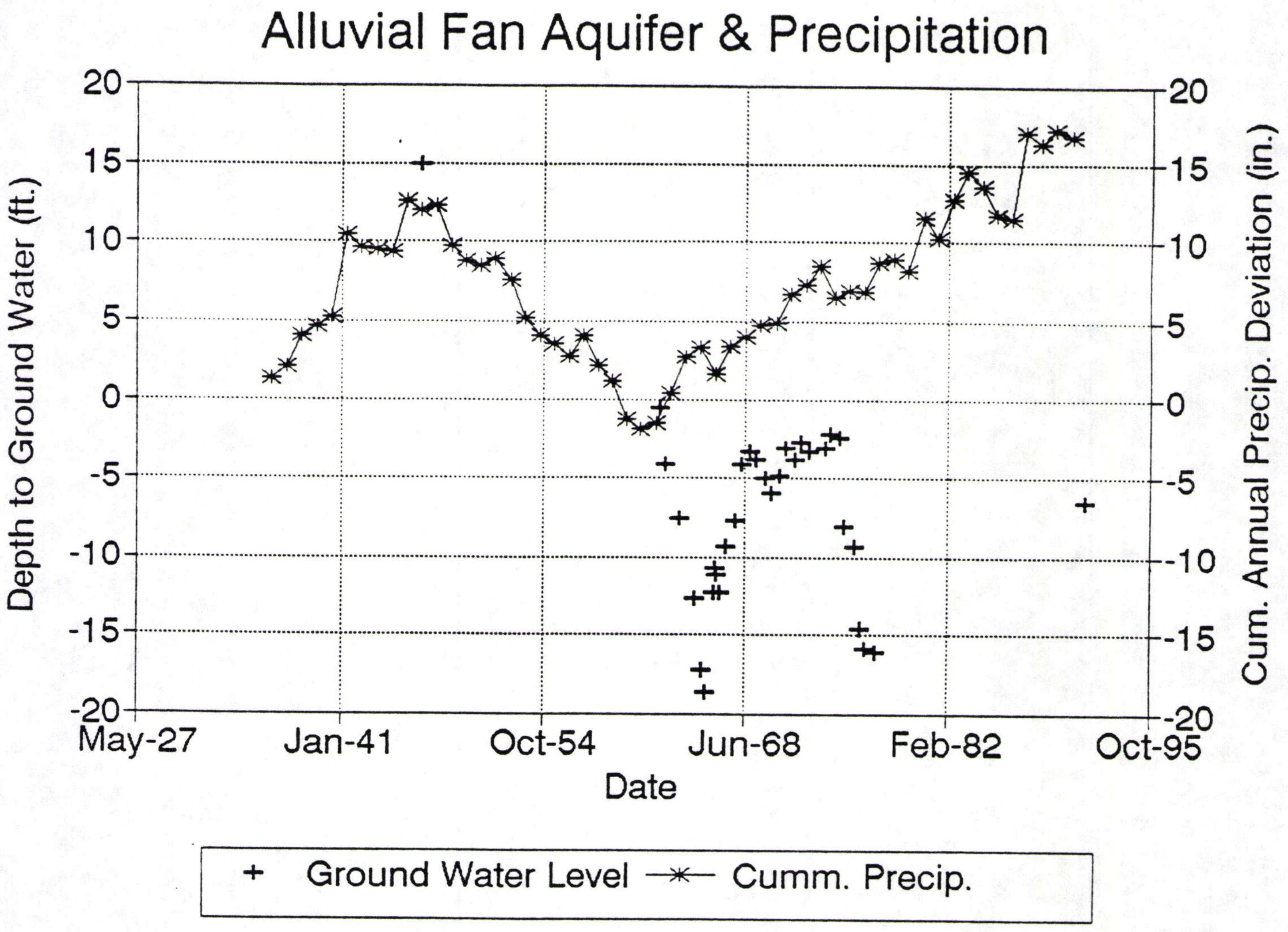

Alluvial Fan Aquifer & Precipitation
Depth to Ground Water (ft.)
Cum. Annual Precip. Deviation (in.)
20
15
10
5
0
-5
-10
-15
-20
May-27
Jan-41
Oct-54
Jun-68
Feb-82
Oct-95
Date
Ground Water Level
Cumm. Precip.

Figure 2

for 50 hours in 1967, at 1800 gpm. The results of the pumping tests are presented in Turk's 1969 and 1973 publications. Transmissivity values ranged from 185,000 gpd/ft to over 400,000 gpd/ft. Storage coefficient values ranged from 0.00014 to 0.00046. The higher values resulted from analyses of data in Well 9, which at the time of drilling had much higher artesian flow than other wells. The lower data resulted from data from Well 10, which appears to be more representative of other wells. The proposed plan (see Plate 1) includes four wells. One well would be drilled in the vicinity of Well 10 which location is expected to have greater productivity. We have assumed T=290,000 gpd/ft and S=0.00024 for the well of greater production (2100 gpm) and T=190,000 and S=0.0014 for the other wells which are expected to produce 1300 gpm each. A drawdown analysis using these parameters was performed to determine interference between the wells and impact on the existing Reilly wells. The results are graphically presented in Figure 3. The drawdown on Figure 3 is aquifer drawdown and does not include hydraulic well losses. The assumption used in the analysis was a period of pumping of 120 days and a non-equilibrium condition. We assume that equilibrium will occur at least on a seasonal basis. Anticipated conditions in the alluvial fan aquifer influenced the location of the fourth well. This well was located some 4500 feet to the northeast of the nearest new well. It is anticipated that the nearby outcrop would limit recharge for a well located too near it and near other pumping wells.

The location of the proposed wells was also influenced by the existing powerline which ends at the third well (NW-3). The fourth well would require construction of 4500 feet of new powerline and cleaning of additional channel.

Brackish Water Supply Channels

It is proposed to use existing channels to move the brackish water from the wells. Some cleaning and enlarging of the channels will be required. Cross-sections of the channels and hydraulic data are included in Appendix A. The hydraulic data and stationing on some of the cross sections reflect an alternate plan for a flowrate of 3,000 gpm rather than the proposed flowrate of 6,000 gpm. The most significant restriction in the supply channels is the timber culvert under I-80. The culvert is more than half filled or blocked by sediment and debris. It is presently anticipated that a new culvert or conduit will be constructed under the railroad near the existing pumping station (near Sta 190). It is anticipated that an additional pumping plant will be required near Sta 190. Another alternative would be to replace the existing pump and pipeline with a new one. It is possible that with more detailed profile information and refined hydraulic analyses during final design, that the pumping may be eliminated.

South of the railroad it is proposed to use an existing transfer canal which terminates at the northwest corner of the primary pond. The channel is large with a bottom width generally greater than 35 feet. Some localized cleaning will be required. A pumping station will be required at the northwest corner of the primary pond. The pumping

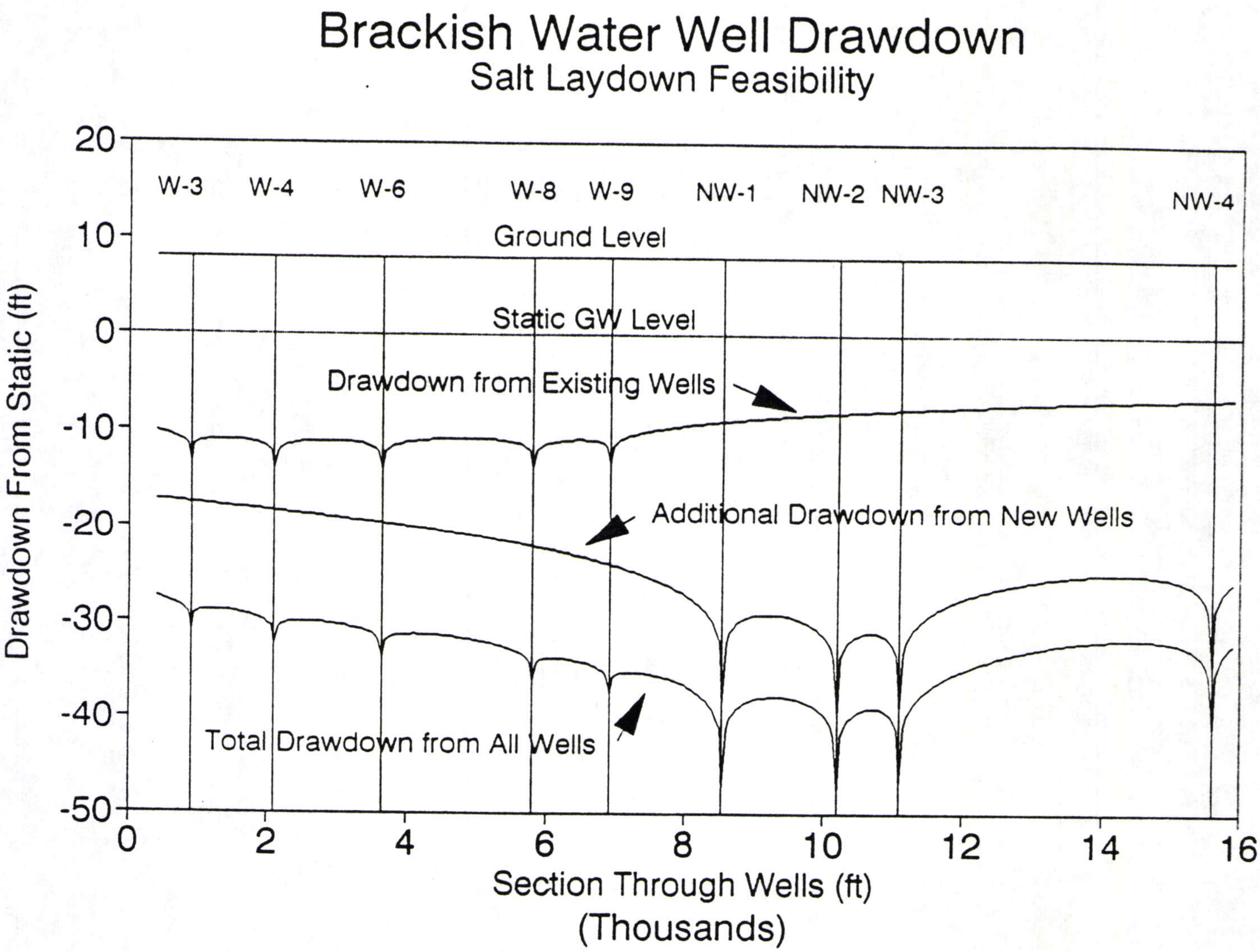

Brackish Water Well Drawdown
Salt Laydown Feasibility
W-3
W-4
W-6
W-8
W-9
NW-1
NW-2
NW-3
NW-4
Ground Level
Static GW Level
Drawdown from Existing Wells
Additional Drawdown from New Wells
Total Drawdown from All Wells
Drawdown From Static (ft)
20
10
0
-10
-20
-30
-40
-50
0
2
4
6
8
10
12
14
16
Section Through Wells (ft)
(Thousands)

Figure 3

requirements are discussed in below. The discharge line from the pumping station will cross a deep collection ditch which borders the retired primary pond. A culvert is proposed to be installed at this location in the collection ditch.

Primary Pond IV North (Salt Pond)

The primary pond is also referred to as the salt pond in other sections of this study. The original Primary Pond IV North was considerably larger than the portion proposed to be initially used. The proposed pond is 1.44 square miles in size (922 acres). The salt thickness is 3.5 to 4 feet thick as indicated by Reilly personnel and measured during this study. The volume of salt in the pond is sufficient to cover the 28 square-mile area of the salt flats with approximately 2 inches of salt if all salt were transported and uniformly deposited. The pond currently has a baffle dike in the center. It is proposed to use half of the pond at a time which would require extending the salt dike on the north end and excavating a channel at the south end. It is proposed to build a dike with dozed salt although a more positive cutoff with clay or a membrane may be required to contain the brine.

No information was available on the chemical composition of the salt in the pond. It is anticipated, however, that the salt in the pond is almost entirely sodium chloride, due to the process of it deposition. The salt is solid and hard, especially below about two feet. A water table 2 feet deep was observed in the south central part of the pond. Samples of the salt tested in our materials lab indicated a mean density for the salt of 108.8 pcf.

The dissolving process in the salt ponds has been considered in the past. It is the experience of Reilly that a "slime" forms on the surface of the salt and inhibits further dissolution. It has been found that ripping of the salt to increase the specific surface and to eliminate the flat bottom aids in the dissolution process. The proposed plan includes ripping of the salt surface on 20-foot centers.

Freshening Pump

The concentration of the brine from the salt pond is important in efficiently conveying the salt to the salt flats and in avoiding the "salt point" in the conveyance process. If the brine is at saturation during pumping or in the brine canal, precipitation will occur and will restrict or block flow. The actual brine concentration from the salt pond will vary depending on the formation of slime, the specific surface (created ripping) of the salt in the pond, the evaporation losses, and the flowrate. It is proposed to install a small pump in the transfer canal near the southeast corner of the salt pond. The pump would provide lower specific gravity water to the brine stream to maintain concentrations slightly below saturation. This would require monitoring by personnel or instrumentation.

Brine Canal

The proposed brine canal will cross two operating collection ditches east of the salt pond. It is proposed to place corrosion resistant culverts in the bottom of the ditches and brine culverts across fill in the collection ditches. Sections of these culverts are included in Appendix A.

Several existing channels east and north of the salt pond are abandoned collection ditches which have filled with wind blown gypsum. The wind blown gypsum has the appearance of sand but is soluble. These ditches are generally up to 20 feet deep. Use of these ditches would result in seepage losses possibly high enough to loose all brine. It is proposed to build a new canal as shown on Plate 1 and in the cross-sections. A new crossing at the railroad will be required unless a pumping station is located south of the railroad. With a pumping station south of the railroad, existing 36-inch culverts could be used for the pressure conduit.

Existing channels, with some cleaning and obstruction removal, would be used between the frontage road and I-80.

I-80 Crossing

Three alternatives were considered for crossing I-80. They are shown on Figure 4. The existing timber culvert at the west end of the Salduro Loop, is deep and possibly filled with sediment. It was reported to be closed off with bulkheads at the time of construction of I-80, but some water does move through it. The headwalls of the south end of the culvert are visible but the structure is buried on the north end. There is some unknowns about the condition of culvert.

Six 36"x22" arch pipe culverts exist just west of the rest stop. These are open and set at the grade of the salt flats inside the Salduro Loop and could provide the conveyance under the freeway. Use of these culverts would require all brine to move through the area of the Salduro Loop which has some advantages and some disadvantages.

The proposed plan utilizes the timber culvert to cross I-80 with the distribution system of Alternative 3 of Figure 4.

Distribution System

After crossing the interstate, the brine would be conveyed into the area between the frontage road and the north side of I-80. Culverts would be installed in the frontage road at grades and spacings which would provide for uniform flow distribution onto the salt

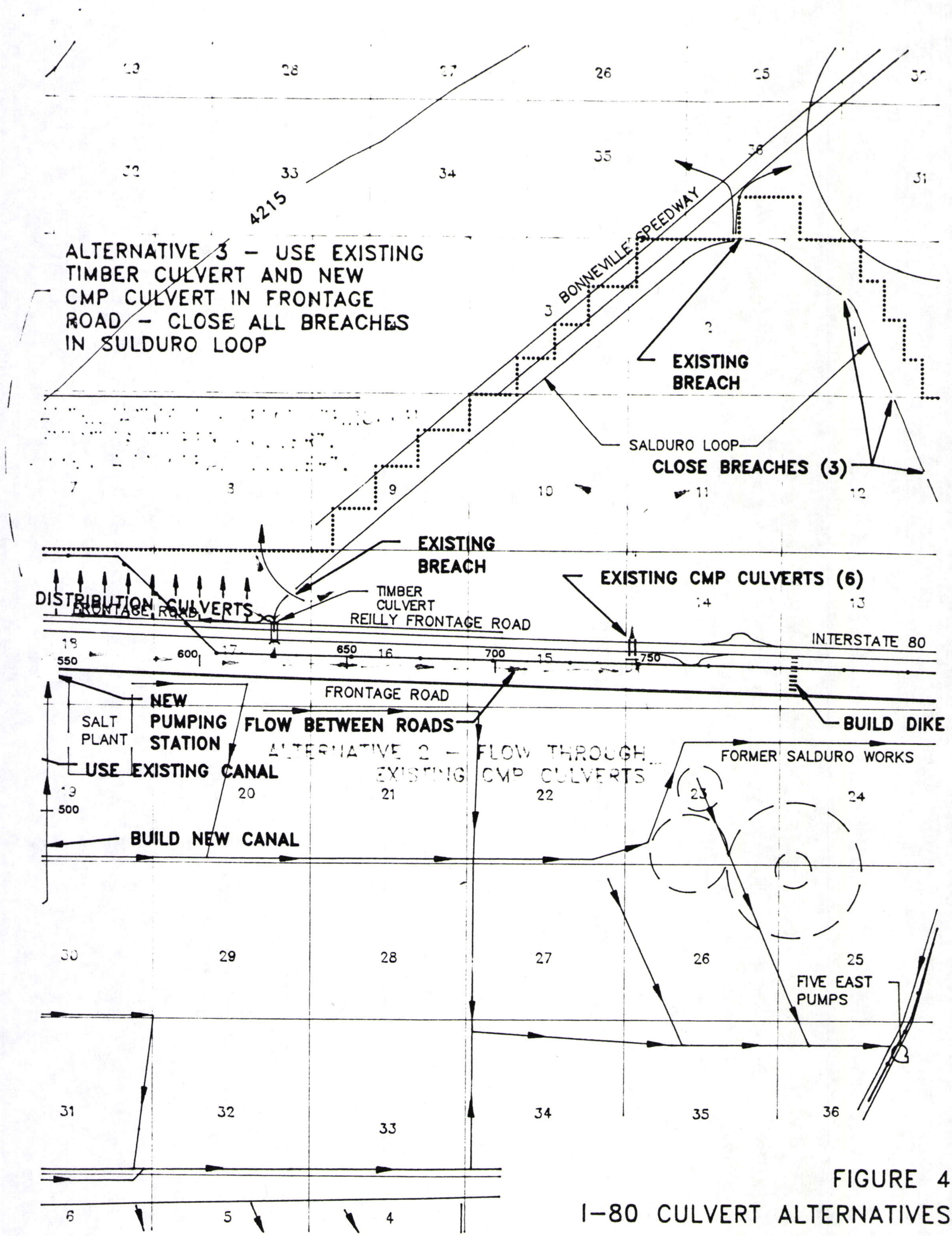


FIGURE 4
I-80 CULVERT ALTERNATIVES AND DISTRIBUTION SYSTEMS

flats and avoid erosion, scour, and excessive dissolution of the existing salt crust. Simple gating could reduce flow where dissolution occurs.

Salduro Loop

The Salduro Loop north of I-80 consists of the remnants of an old collection ditch and the spoil from the excavation of the ditch effectively forming a dike outside the loop. There are several breaches in the Salduro Loop which should be closed to prevent migration of brine to the east, thereby increasing the laydown area. It is presently proposed to close four of the breaches, leaving one breach on the east dike as it is.

Clay Containment Dikes

To inhibit movement of brine to the northeast and east, a low dike should be built connecting the topographic rise of Floating Island to the mounds on the west side of the brine collection ditches. Two alternatives are shown on Figure 5. Remnants of a previous dike could be used to complete the barrier. The remnant is not in good condition and would have to be rebuilt. However, if the dike is built on the east side of the old dike, some brine will be trapped between the two and be prevented from flowing back to the racetrack area. It is proposed to use the alignment of Alternative 2 on Figure 5.

Salt Containment Dikes

The proposed plan would include a salt windrow or dike from the Salduro Loop dike to the dike along the brine collection ditches. It would be constructed by grading a limited thickness of the salt crust. It would require maintenance or total replacement each year. The dike may require importing of "green salt". It is intended that the dike be from 12" to 18" in height. It could be overtopped during a strong north wind.

Pumping Stations

Two and possibly four pumping stations will be required. The required horsepower of the pumps is expected to b:

Sta 190	15 Hp
Sta 265	20 Hp
Sta 370	2 Hp
Sta 640	15 Hp

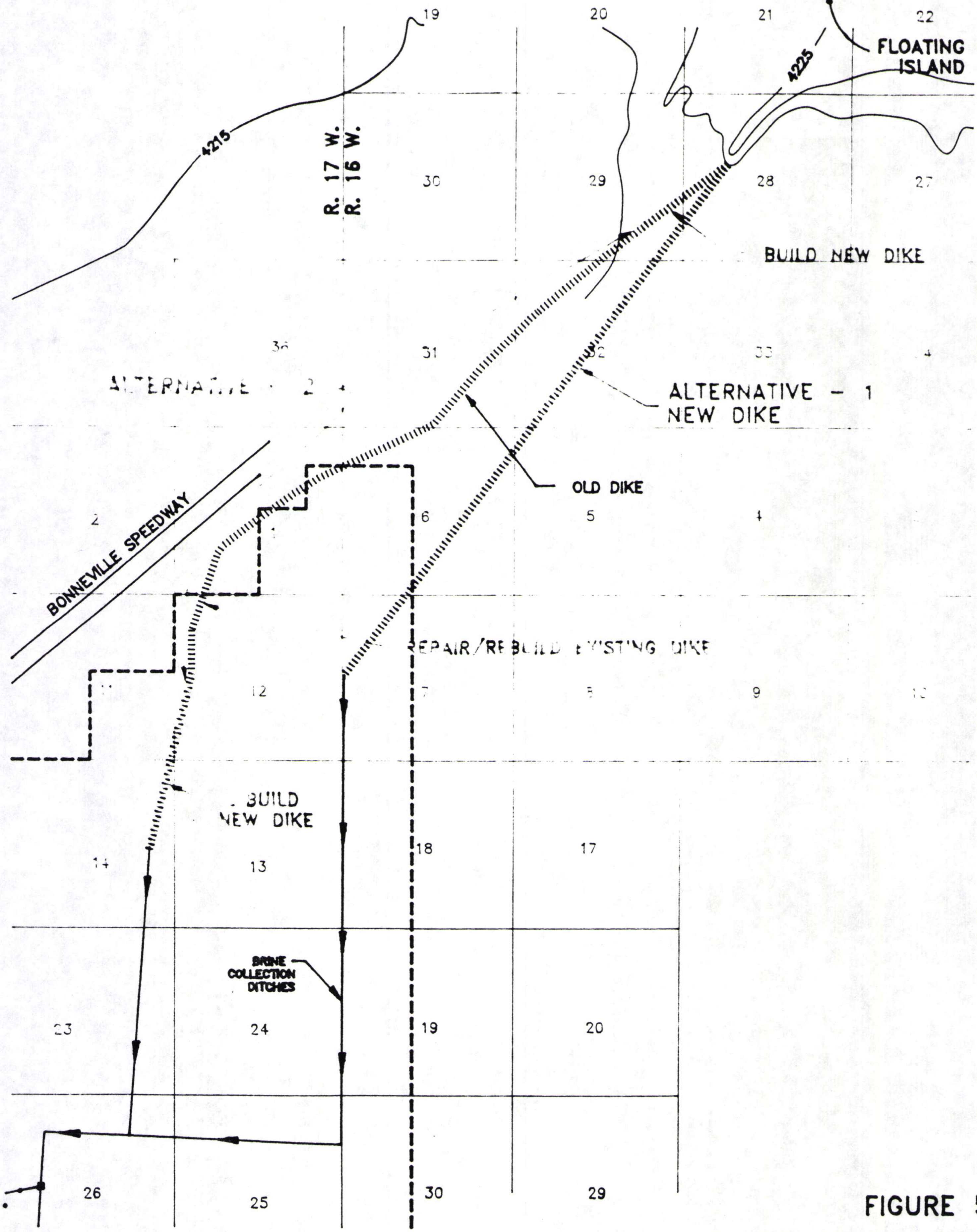


FIGURE 5
CONTAINMENT DIKE ALTERNATIVES

Frontage Road Improvements

It is proposed to improve approximately 8 miles of the existing frontage road south of I-80 between the overpass and the Reilly #2 Booster Pump. The existing paved road is badly deteriorated with many localized areas of settlement. The most cost effective method of improving the road appears to be to asphalt patch the first 1.3 miles of road and remove the asphalt from the remainder of the road. After removal of the asphalt the gravel below the asphalt would be graded. It would be left as a graded graveled road with magnesium chloride treatment.

SALT TRANSPORT MODEL

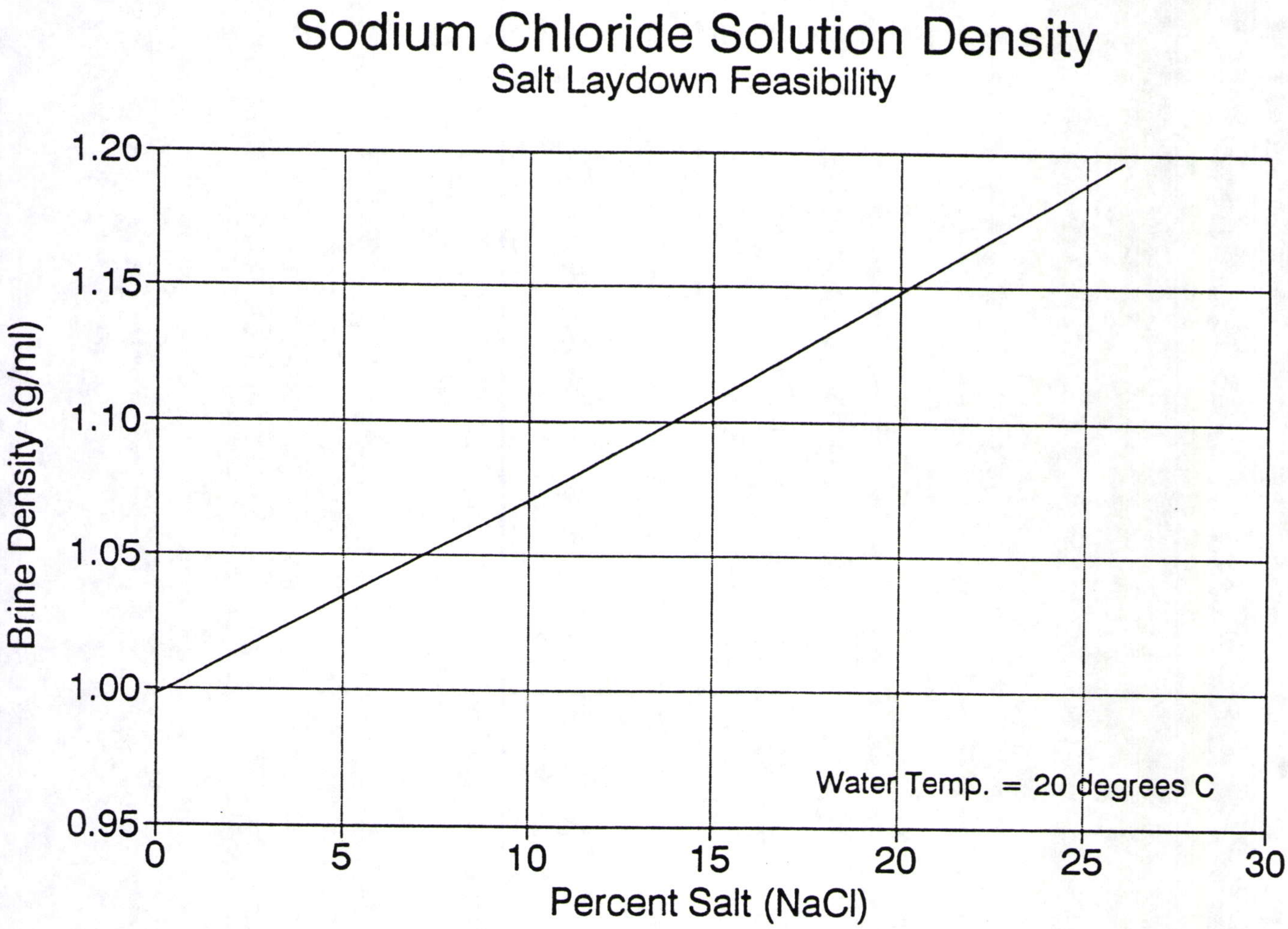
A numerical model was created to simulate the hydraulic, dissolution, evaporation, and precipitation processes. The printouts of the model in Appendix C indicate the detail of the model. Data summarized on Figures 6, 7, and 8 were utilized in the model. Parameters included in the model include:

- Flowrate from pumps and at other locations as diminished by evaporation and leakage
- Specific gravity of brackish water and brine
- Evaporation of brackish water and brine as influenced by specific gravity and concentration and area of conveyance area
- Leakage from conveyance system
- Area of salt flats (brine containment area).
- Size of primary (salt) pond where dissolving of salt would occur.
- Duration of pumping.
- Permeability of soils and groundwater levels beneath canals, ponds, and salt flats.

Variations in the above parameters were investigated in evaluating numerous alternatives. The proposed plan includes the following parameters:

- Salt flat brine containment area = 28 square miles
- Rate of brackish water pumping = 6,000 gpm
- Initial portion of salt pond = 390 acres
- Duration of pumping = 6 months
- Specific gravity of brine leaving salt pond = 1.18
- Vertical permeability of salt flat soils = 1×10^{-6} cm/sec

Evaporation rates were based on studies by Turk. Pan evaporation rates for fresh water were determined in 1976. Average annual and 1976 weather data are shown in Table 2. No specific adjustments were made for pan evaporation for the deviation from long



Sodium Chloride Solution Density
Salt Laydown Feasibility
Brine Density (g/ml)
1.20
1.15
1.10
1.05
1.00
0.95
0
5
10
15
20
25
30
Percent Salt (NaCl)
Water Temp. = 20 degrees C

Figure 6

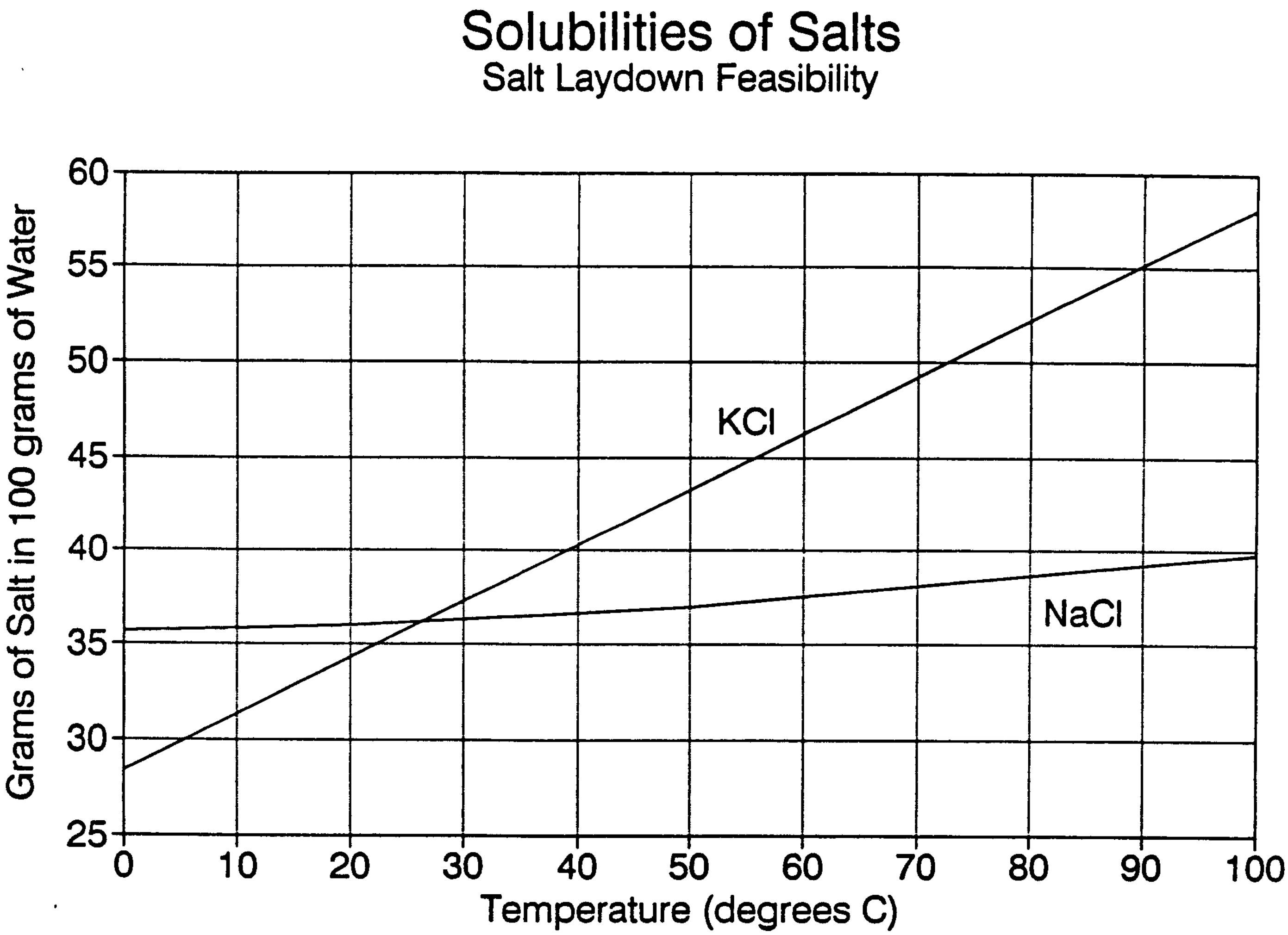

Solubilities of Salts
Salt Laydown Feasibility
Grams of Salt in 100 grams of Water
60
55
50
45
40
35
30
25
KCl
NaCl
0
10
20
30
40
50
60
70
80
90
100
Temperature (degrees C)

Figure 7

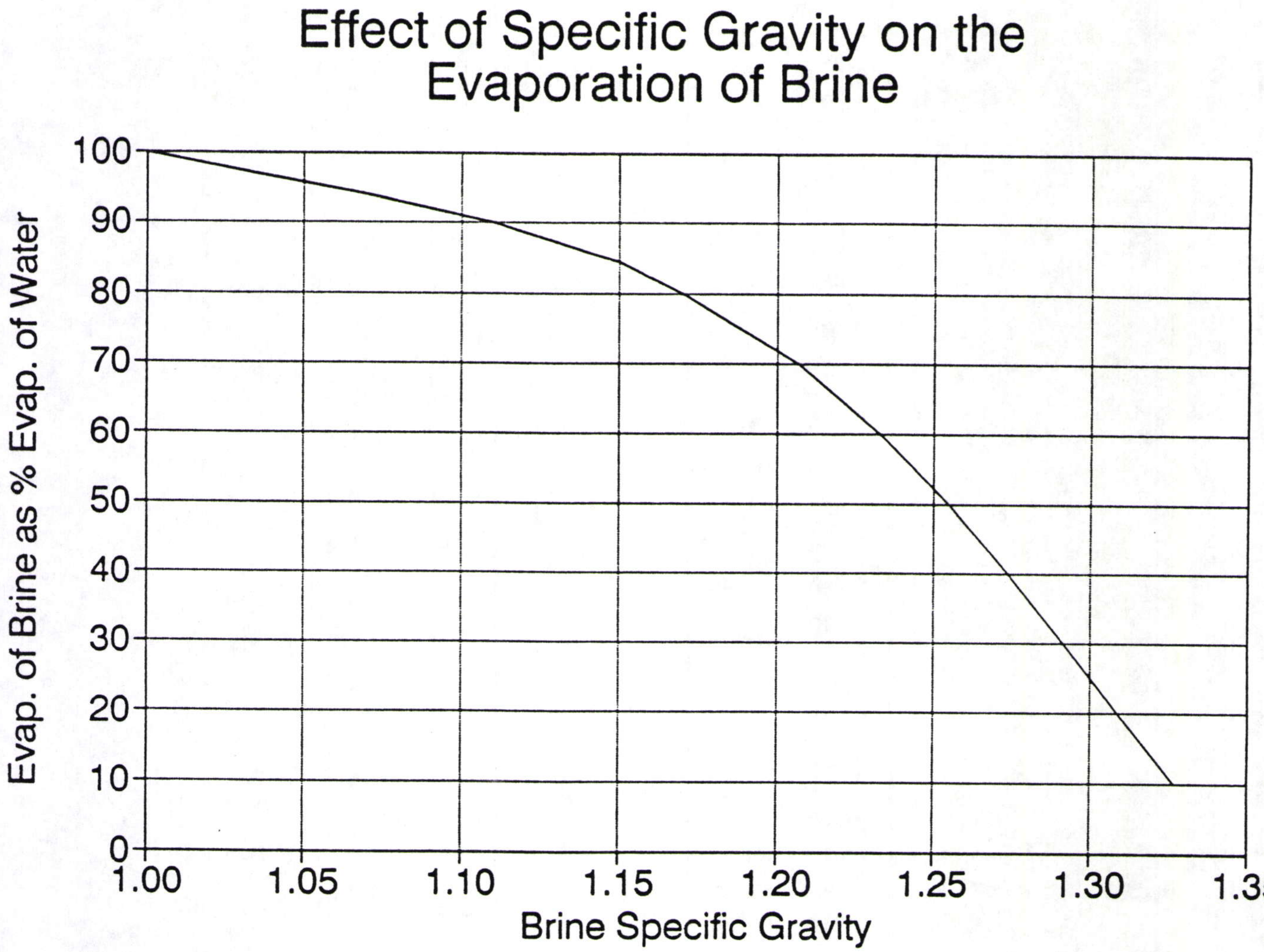

Effect of Specific Gravity on the
Evaporation of Brine
Evap. of Brine as % Evap. of Water
100
90
80
70
60
50
40
30
20
10
0
1.00
1.05
1.10
1.15
1.20
1.25
1.30
1.35
Brine Specific Gravity

Figure 8

term averages. Evaporation potential for 71% of fresh water pan rates are shown, however all model calculations were based on the relationships shown on Figure 8.

Laydown areas, or the area of the salt flat over which the brine will spread, were evaluated based on existing dikes and natural features. It is assumed that the spreading of the brine will be limited to the west edge of the existing salt crust. It will also be contained by the Salduro Loop dike, the dikes along the brine collection ditches, and the clay and salt containment dikes shown on Plate 1.

Seepage was calculated using a vertical permeability coefficient of 1×10^{-6} cm/sec and gradients varied during the year to reflect estimated changes in groundwater levels. Only the upper 6 feet of clay soil was considered in the seepage calculations. Horizontal permeability is known to be much greater than 10^{-6} cm/sec, however, with cutoffs under canal banks and the geometry of ponded areas, vertical permeability will control seepage.

The results of some of the alternatives are summarized in Table 3. These results are shown to indicate the sensitivity of the process to the variation of some parameters.

COST ESTIMATE

Total project costs have been estimated at $797,000. The prices used in the cost estimate are for new construction and equipment at market prices, and for contractors mobilizing from Salt Lake City. The cost estimate also includes costs for work and several features which may be found unnecessary during final design. In addition, the use of Reilly wells would reduce well construction costs. The use of Reilly equipment may result in additional significant savings. It is anticipated that potential cost savings could be as much as $210,000, resulting in a construction cost of $587,000. This does not include other additional savings in well construction which the racing associations have indicated were possible through their contacts. A detailed cost estimate is shown on Table 4.

PROPOSED PROJECT SCHEDULE

Shown on Figure 9 is a project schedule which, if implemented during September or October of 1991, will put the first brine on the salt flats by the end of 1992.

It is recommended that for an immediate beneficial effect, the containment dike from the south end of Floating Island to the north end of the Reilly collection ditches be constructed prior to the winter of 1991-92. The above work can be accomplished during the final design for the remainder of the project.

Table 2

AVERAGE MONTHLY EVAPORATION AND WEATHER DATA

Bonneville International Raceway Salt Laydown Feasibility

Month	Bonneville Salt Flats 1976 Temp. (F)	Precip. (in)	an Evap (in)	Wendover 1924–1986 Temp. (F)	Precip. (in)	Deviation 1976 to Record Temp. (F)	Precip. (in)	Pond Evaporation Fresh Coeff=0.71 (in)	Brine @ 73% (in)
Jan.	28	0.03	1.10	27.7	0.28	0.3	–0.25	0.78	0.57
Feb.	33	0.47	1.64	33.9	0.31	–0.9	0.16	1.16	0.85
March	38	0.03	5.23	41.7	0.36	–3.7	–0.33	3.71	2.71
April	49	0.36	4.99	50.4	0.45	–1.4	–0.09	3.54	2.59
May	64	0.83	10.20	60.9	0.78	3.1	0.05	7.24	5.29
June	69	0.09	14.20	70.6	0.57	–1.6	–0.48	10.08	7.36
July	80	0.23	15.30	79.8	0.24	0.2	–0.01	10.86	7.93
Aug.	72	0.56	11.90	77.0	0.40	–5.0	0.16	8.45	6.17
Sept.	68	0.21	7.72	65.9	0.34	2.1	–0.13	5.48	4.00
Oct.	51	0.23	4.09	52.1	0.45	–1.1	–0.22	2.90	2.12
Nov.	37	0.04	2.89	38.2	0.36	–1.2	–0.32	2.05	1.50
Dec.	23	0.00	1.26	28.6	0.30	–5.6	–0.30	0.89	0.65
Annual	51	3.08	80.52	52.2	4.84	–1.2	–1.76	57.17	41.73

Table 3

RESULTS OF SALT TRANSPORT MODEL

Bonneville International Raceway Salt Laydown Feasibility

Operation Alternatives		Duration of Pumping (months)	Primary Pond Size (acres)	Pumping Rate (gpm)	Salt Flat Area (sq mile)	Added Salt Thickness per Year (in)
No.	Appendix Table					
1	C-1	6 Oct-Mar	390	6000	28	0.42
2	C-2	6 Nov-Apr	390	6000	28	0.42
3	C-3	5 Nov-Mar	390	6000	28	0.35
4	C-4	3 Nov-Jan	390	6000	28	0.21
5	C-5	6	390	6000	34	0.34
6	C-6	6	890	6000	34	0.26
7	C-7	6	890	3000	34	0.06
8	C-8	6	390	3000	28	0.16
9	C-9	6	890	6000	28	0.32

Table 4

COST ESTIMATE

Bonneville International Raceway
Salt Laydown Feasibility

ITEM		QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Drill 2100 gpm Well	400	LF	$54.00	$21,600
	Casing & sand pack	400	LF	40.00	16,000
	Mill slots	360	LF	5.00	1,800
	Surface seal	20	LF	40.00	800
	Cleaning & Developing	16	HR	150.00	2,400
	Test Pumping	1	LS	4,000.00	4,000
	50 Hp Pump, Controls, Installation	1	LS	14,000	14,000
2	Drill 3 – 1300 gpm Wells	1,050	LF	$50.00	$52,500
	Casing & sand pack	1,050	LF	36.00	37,800
	Mill slots	840	LF	4.50	3,780
	Surface seal	60	LF	40.00	2,400
	Cleaning & Developing	48	HR	150.00	7,200
	Test Pumping	3	LS	3,500.00	10,500
	30 Hp Pump, Controls, Installation	3	LS	9,000	27,000
	Extend powerline to fourth well	1	LS	29,500	29,500
3	Excavate & clean supply ditches	7,300	LF	0.60	4,380
4	Clean & enlarge supply canal	8,800	CY	1.25	11,000
	Plug (dike) old canal	1	LS	250	250
5	Clean I-80 timber culvert	1	LS	3,500	3,500
6	Pump Station, Equipment (Type 1, 30 Hp)	1	LS	13,250	13,250
	Structure	1	LS	4,000	4,000
	Electrical	1	LS	2,100	2,100
	Earthwork	300	CY	2.50	750
7	Railroad Bore (2)	140	LF	130	18,200
	Pressure Line	200	LF	28	5,600
	Earthwork	2	LS	1,600	3,200
8	Canal Earthwork (Sta 179 to 258)	1,200	CY	2.00	2,400
9	Pump Station, Equipment (Type 2, 40 Hp)	1	LS	15,500	15,500
	Structure	1	LS	4,000	4,000
	Electrical	1	LS	1,900	1,900
	Earthwork	400	CY	2.50	1,000
10	Pressure Line (18″ Spirolite)	250	LF	32.00	8,000
	Culvert in Collection Ditch (24″ CMP, Alluminum)	40	LF	42.00	1,680
11	Rip salt in west half of retired primary pond	120	HR	110.00	13,200
12	Doze salt for salt dike (mound)	40	HR	110.00	4,400
13	Excavate salt pond channel (south corner)	40	HR	100.00	4,000
14	Freshening brine pump (200 gpm) and piping	1	LS	5,200	5,200

Table 4

COST ESTIMATE

Bonneville International Raceway
Salt Laydown Feasibility

	ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
15	Collection ditch crossings (2), Earthwork	1,800	CY	2.25	4,050
	Collection ditch culvert	120	LF	45.00	5,400
	Brine canal culvert	200	LF	32.00	6,400
16	Brine Canal, Cutoffs	38,000	LF	1.10	41,800
	Brine Canal, Embankment fill	41,000	CY	1.20	49,200
	Brine Canal, Embankment grading and rolling	1	LS	5,000.00	5,000
17	Pump Station, Equipment (Type 1, 30 Hp)	1	LS	13,250	13,250
	Structure	1	LS	4,000	4,000
	Electrical	1	LS	1,900	1,900
	Earthwork	300	CY	2.50	750
18	Pressure line under railroad and frontage road	200	LF	32.00	6,400
19	Cleaning & opening channel (Sta 572 to 650)	24	HR	100.00	2,400
20	Opening & cleaning timber culvert at Salduro	1	LS	5,000.00	5,000
21	Close Salduro breaches	1	LS	4,000.00	4,000
22	Containment dike to Floating Island	18,700	CY	1.25	23,375
23	Salt dike (windrow) from Salduro dike to collection ditc	25,000	LF	0.45	11,250
24	Matting contingency for backhoe work	69,700	CY	0.30	20,910
25	Distribution System Culverts	240	LF	22.00	5,280
26	Frontage road asphalt patching	500	SF	2.25	1,125
	Frontage road, removal of asphalt	40	HR	100.00	4,000
	Granular import	500	TONS	5.00	2,500
	Grading & finishing	84,480	SY	0.08	6,758
	TOTAL				$583,538
27	Contingency	15%			87,531
	CONSTRUCTION COST				$671,069
28	Design engineering, geotechnical, specifications	8%			53,686
	Surveying & construction staking				11,760
	Construction engineering & quality control	7%			46,975
	Mileage, per diem, & field equipment				13,950
	TOTAL CONSTRUCTION COST				$797,440

Proposed Project Schedule

Salt Laydown Feasibility

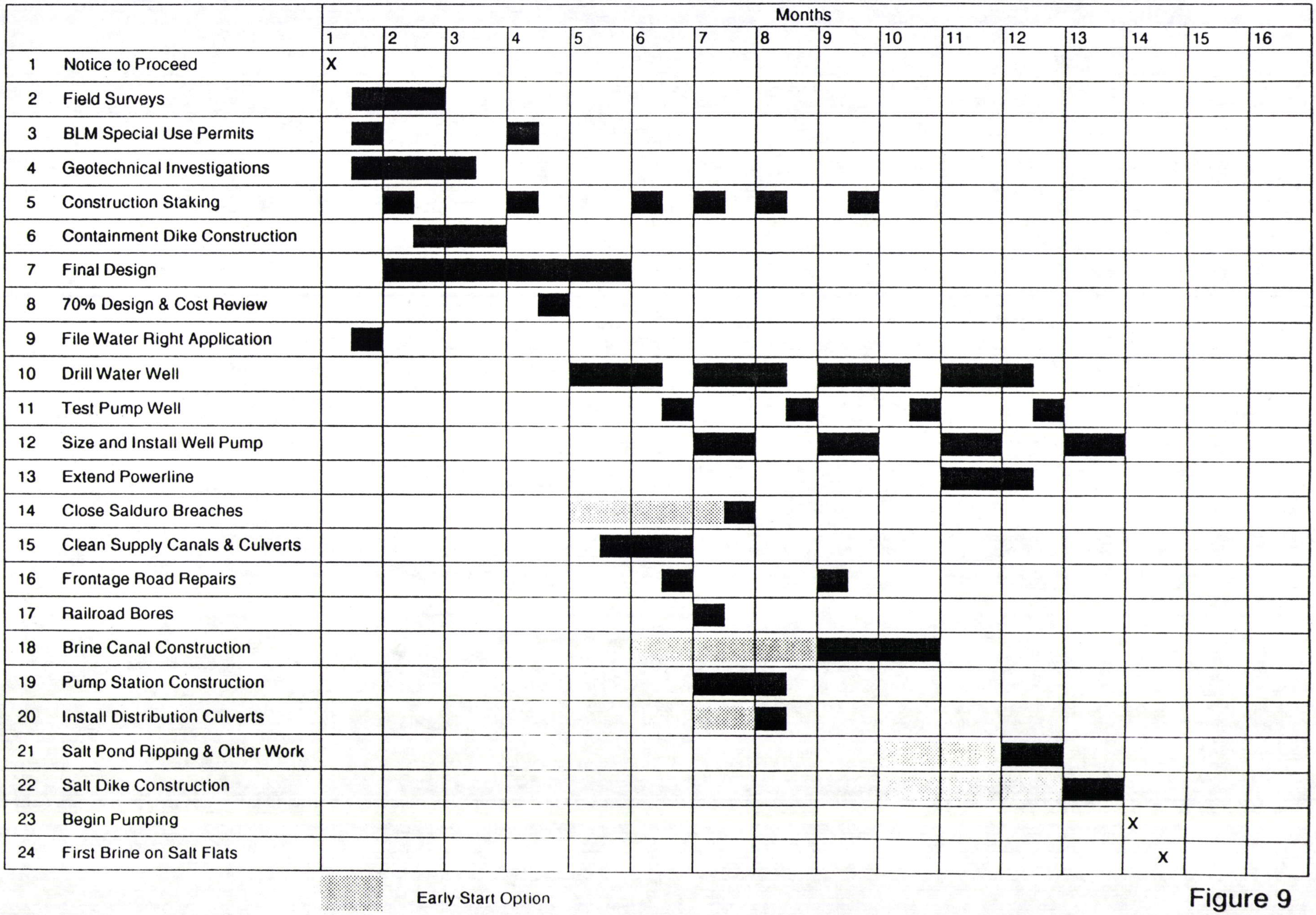


Figure 9

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